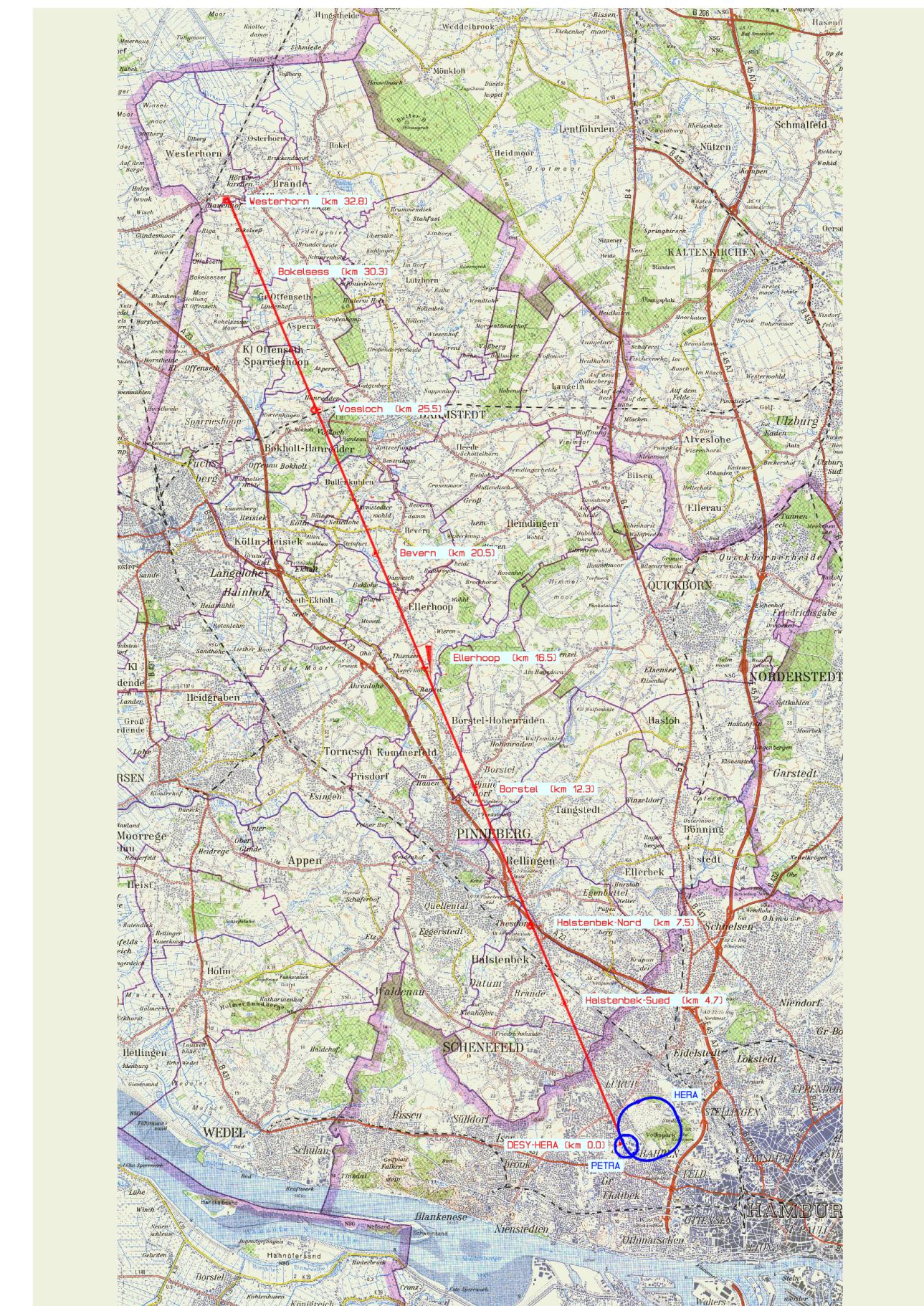
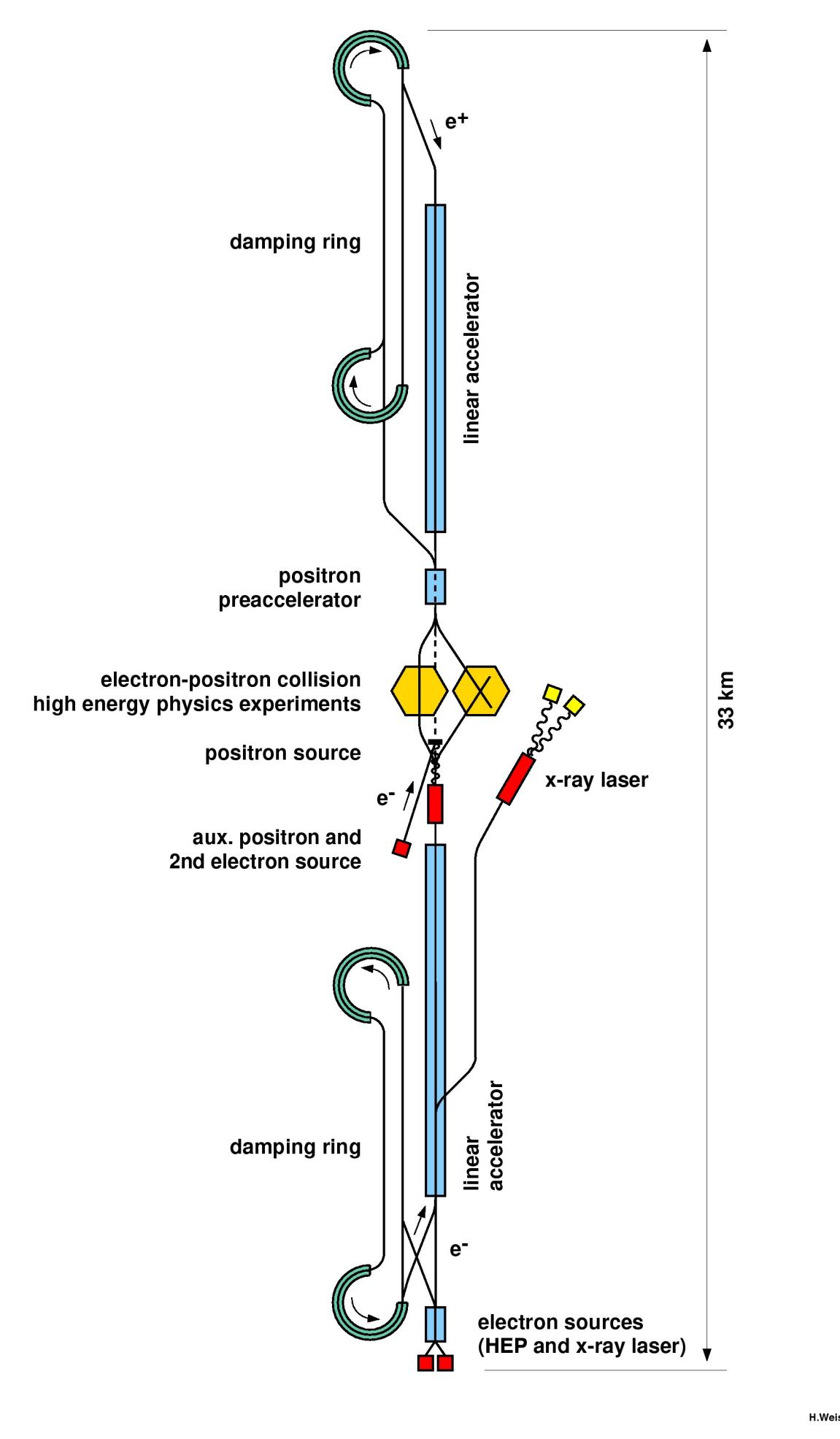
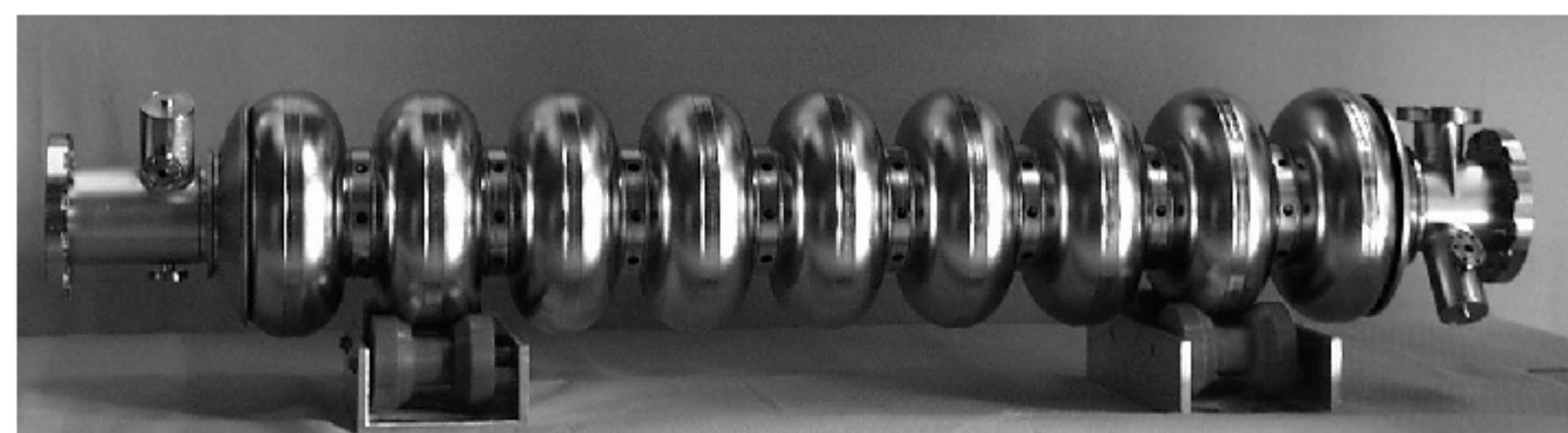


The TESLA 500 Cryogenic Distribution System

S. Wolff, H. Lierl, B. Petersen, DESY, Hamburg, Germany
and
H. Quack, TU Dresden, Germany

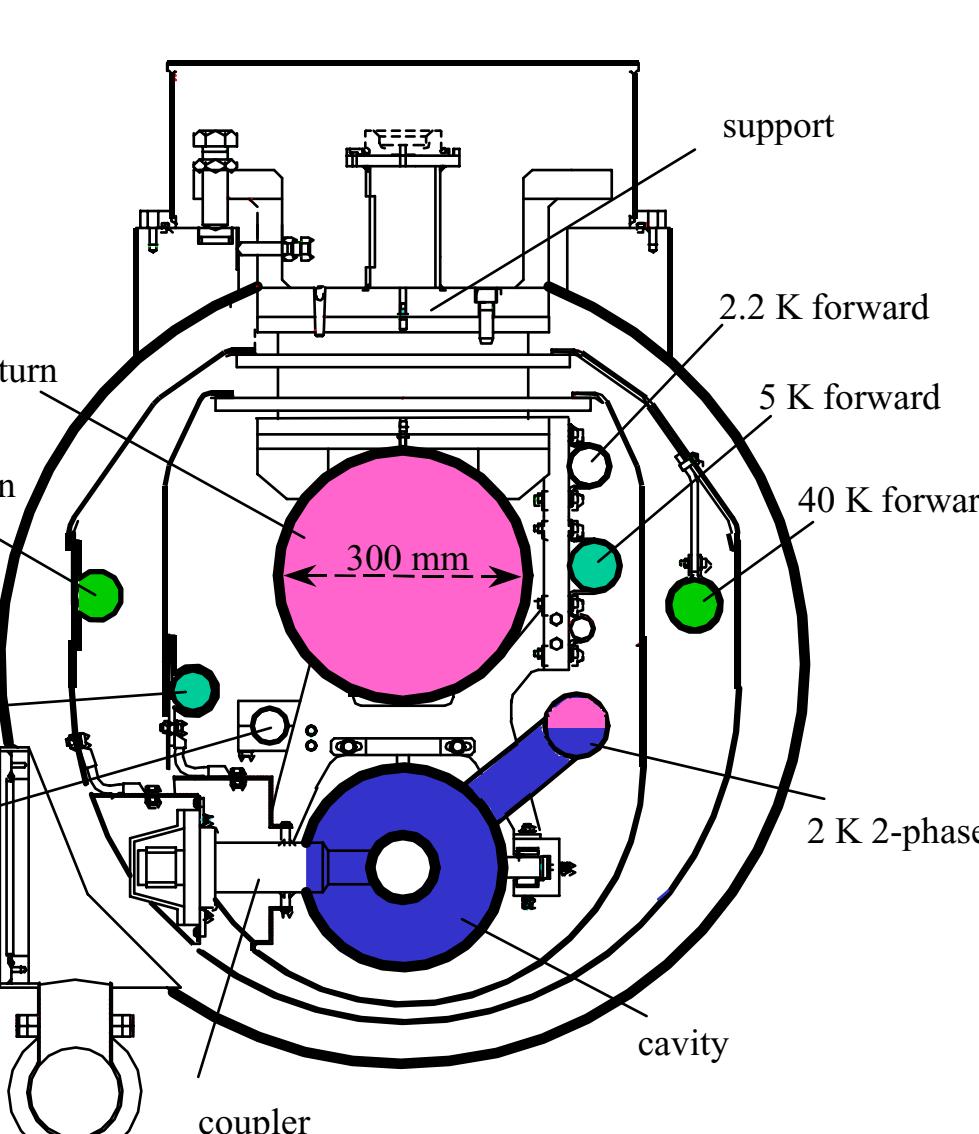
Introduction

- 32 km long e+e- linear collider of 500 GeV (upgradable to 800 GeV) with X-ray FEL of wavelength down to 0.1 nm
- 2 ~ 15 km long main linacs, 250 GeV each
- injectors for e-, polarized e-, FEL e- (500 MeV each) and e+
- pre-accelerators 5 GeV
- 5 GeV damping rings
- proposed site: north-northwest of Hamburg (DESY)
- 5.2 m diameter tunnel, ~ 10 m underground
- acceleration: superconducting cavities, $\approx 2 \times 15$ km long cryogenic structures
- > 21000 cavities, 16-17 m long cryostats (cryomodules)

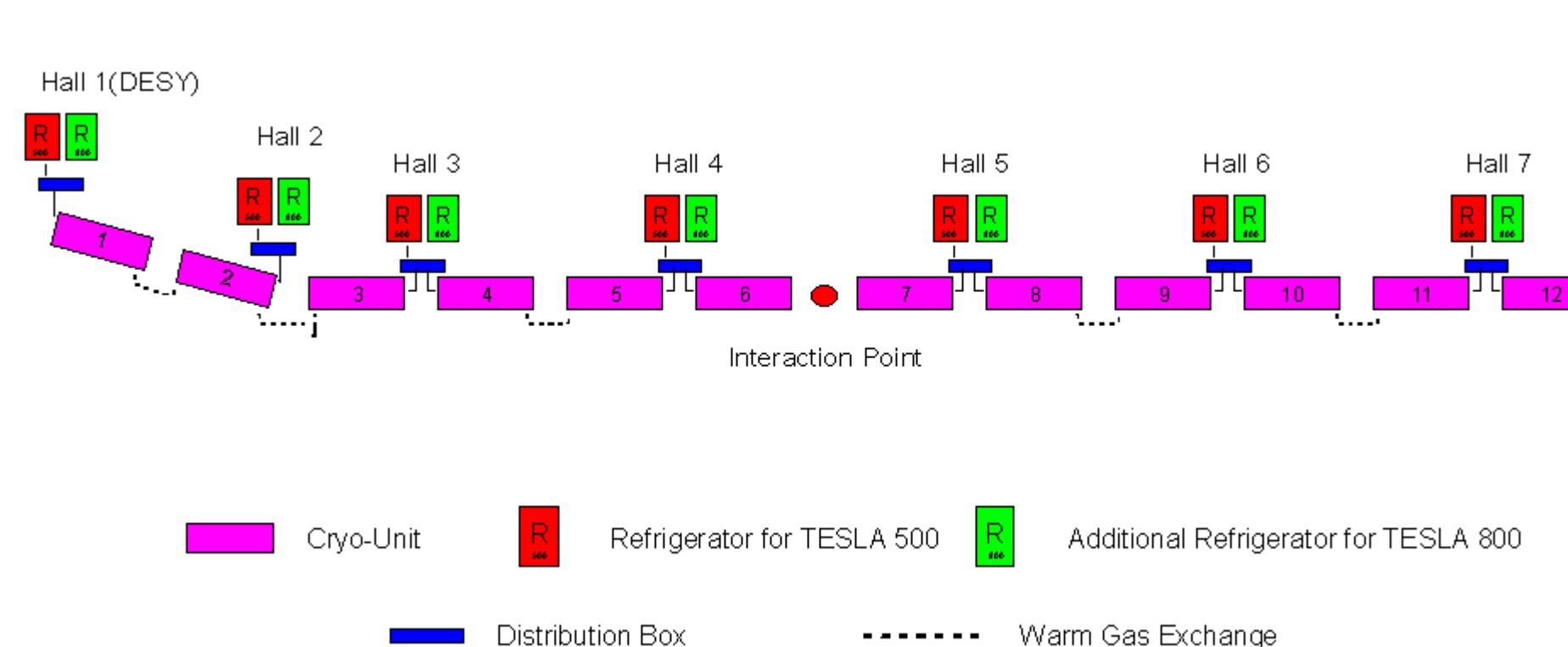


TESLA site (north-northwest of Hamburg)

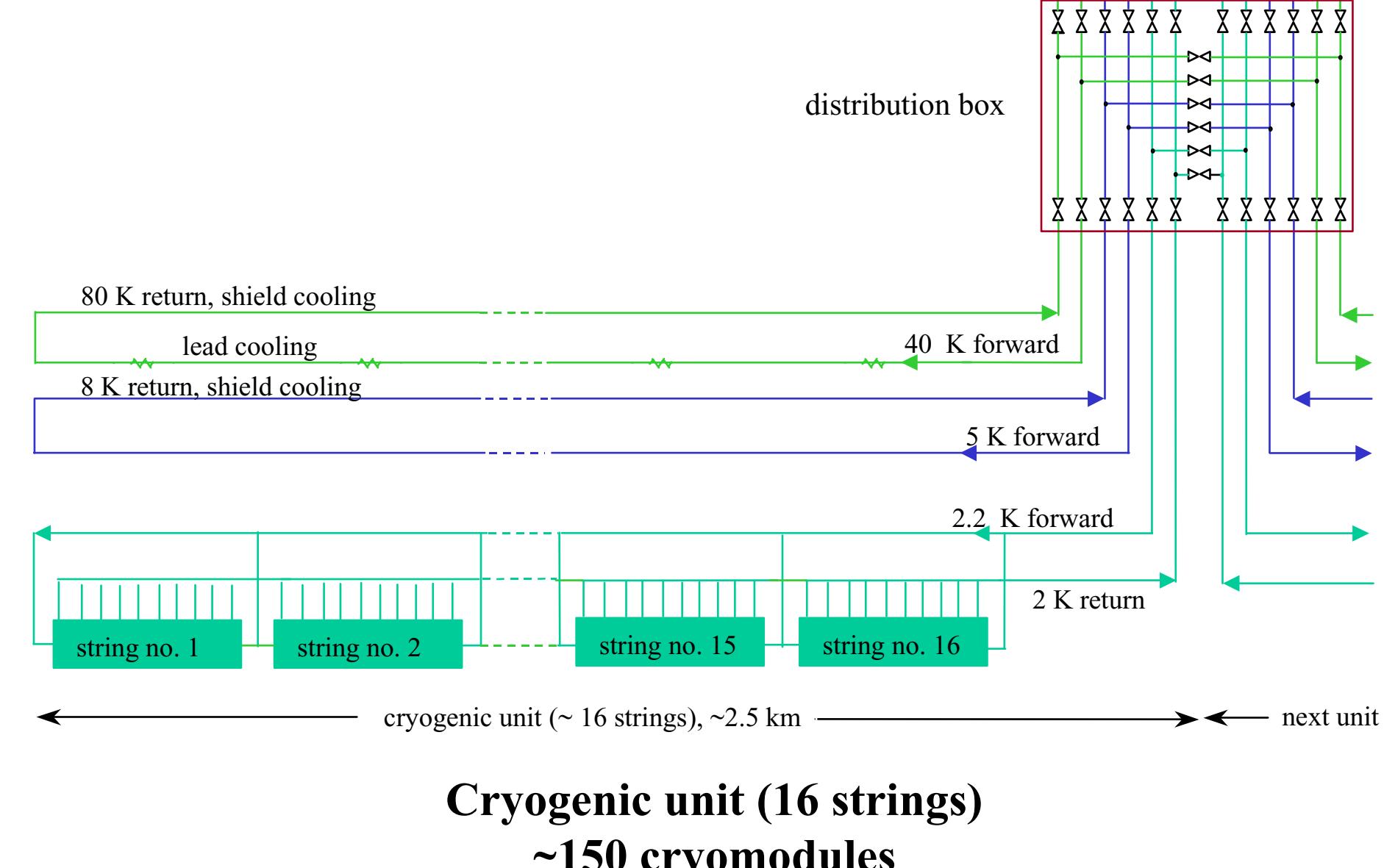
Superconducting 9-cell cavity
1.038 m effective length, pure Nb
 >25 MV/m, $Q_0=10^{10}$ at 2 K, total number > 21000



Cryomodule cross section
12 cavities, magnet package
HTS current leads



Cryogenic system layout (12 cryogenic units)
cryo-hall distance ~ 5 km



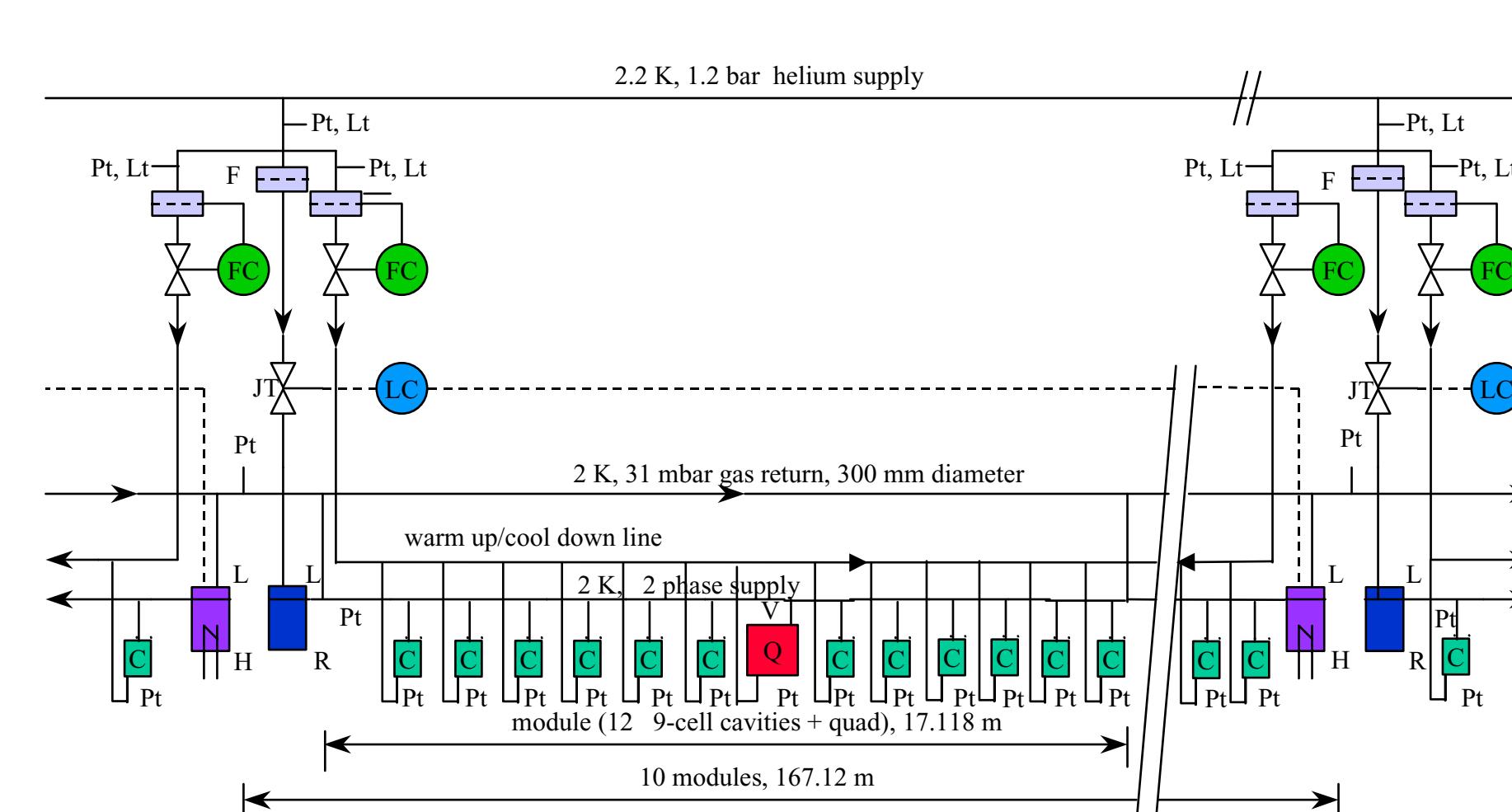
Cryogenic unit (16 strings)
~150 cryomodules
vacuum barriers every 500 m

Main cryogenic components (numbers)

modules (12 cavities, no magnet package)	1004
modules (12 cavities, 1 magnet package)	742
modules (8 cavities, 1 magnet package)	8
modules (4 cavities, 4 magnet packages)	27
vacuum barriers	48
feed-boxes	19
end-boxes	19
injector feed-boxes	3
standard distribution boxes	6
single distribution box	1
injector distribution box	1
transfer lines (m)	824

Instrumentation (numbers)

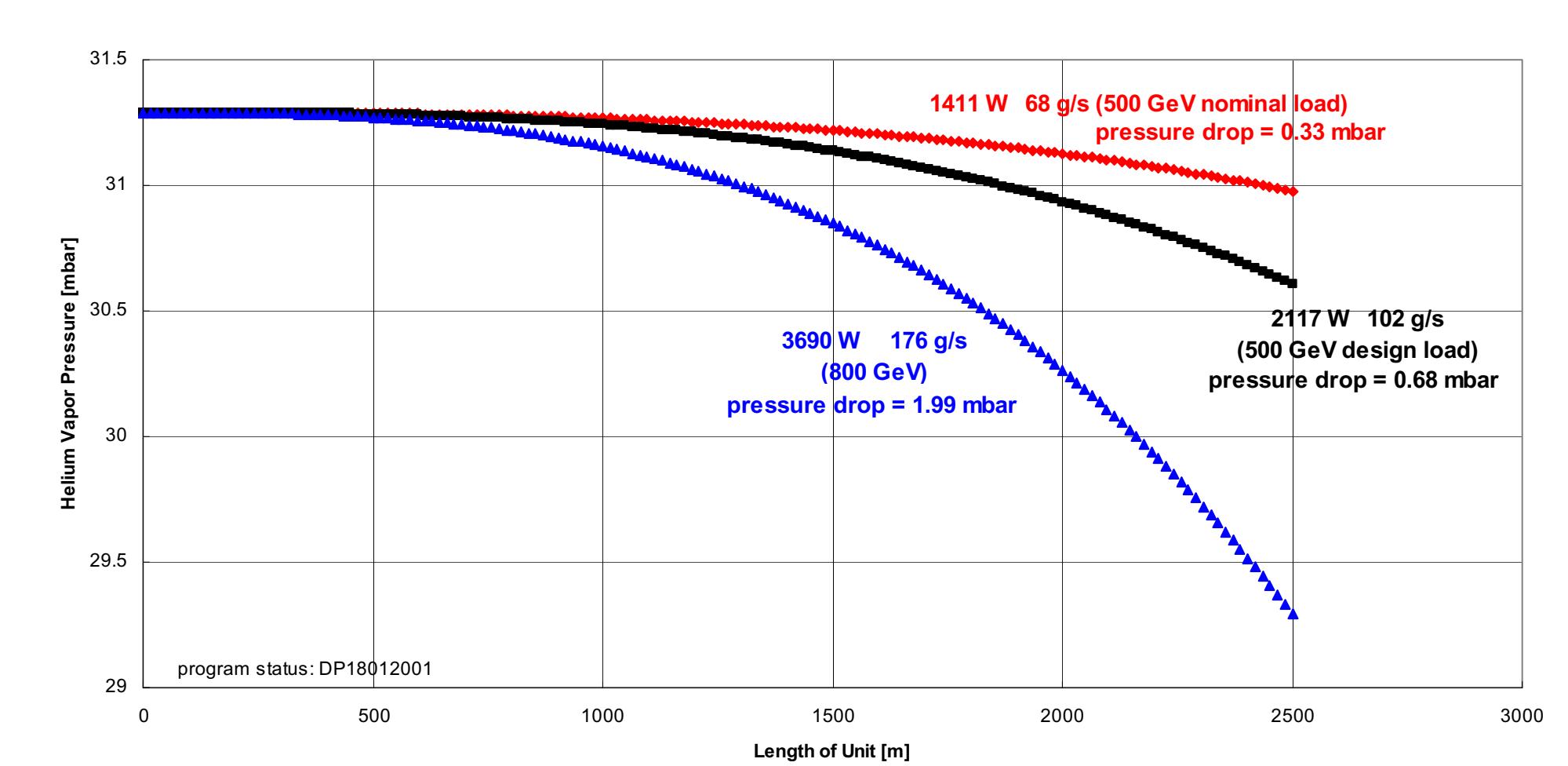
platinum sensors (Pt)	45574
low temperature sensors (Lt)	1322
superconducting level sensors (L)	748
carbon resistor chains	374
cold flow meters (F)	580
electrical heaters (H)	374
HOM antennas	42400
pick-up antennas	21200
e- sensors	21200
BPM antennas	3108
voltage taps	8010
motor steering	21200
piezo-electric quartz steering	21200



Cryogenic string
~10 cryomodules
one special module with valves

Design heat loads [kW] at refrigeration halls

T	hall1	hall2	hall3	hall4	hall5	hall6	hall7
2 K	3.70	3.07	4.23	4.21	3.87	5.13	4.22
5 K	4.73	4.60	7.42	7.39	6.88	8.25	7.36
40 K	44.6	53.5	80.7	79.6	74.4	78.6	80.5



2 K helium vapor pressure drop in gas return pipe ($d=288$ mm)

Operating modes

- cool down:
 - through cool down tubes
 - 10 days to 2 K
 - + 2.5 days filling with liquid
- steady state:
 - level control (JT-valve)
- warm-up:
 - through warm-up tubes
 - 10 days

Upgrade philosophy

- acceleration gradient * 1.6 \Rightarrow 800 GeV
- heat loads scales \sim square of accelerating gradient \Rightarrow higher 2 K mass flow necessary
- double refrigeration capacity \Rightarrow 4 Hz beam pulse repetition rate possible
- distribution box already prepared for upgrade